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## Needle placement under X-ray fluoroscopy using perspective invariants

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*This paper appears in: Mathematical Methods in Biomedical Image Analysis Proceedings. IEEE Workshop on*

Meeting Date: 06/11/2000 - 06/12/2000

Publication Date: 11-12 June 2000

Location: Hilton Head Island, SC USA

On page(s): 46 - 53

Reference Cited: 14

Number of Pages: x+243

Inspec Accession Number: 6657262

### Abstract:

Presents an approach for image-based guidance of a surgical tool towards multiple targets from fixed or variable entry points. The method is based on visual servoing and requires no prior calibration or registration. By taking advantage of projective geometry, precise needle alignment to a target can be achieved in a fixed number (12) of iterations. Alignment to  $n$  targets can be performed in  $6*(n+1)$  iterations. Elements of error analysis and a discussion of the "optimal" placement of the planes used in the method are given. The authors also show how the approach can be used to estimate the entry point and orientation to reach an anatomic target while passing through a given landmark.

### Index Terms:

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